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POLE BLIGHT

WHAT IS KNOWN ABOUT IT

By The
POLE BLIGHT INVESTIGATIONS STEERING COMMITTEE

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

NORTHERN ROCKY MOUNTAIN FOREST AND RANGE EXPERIMENT STATION

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The Pole Blight Investigations Steering Committee

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    Division of Forest Insect Investigations
    Division of Blister Rust Control

  Bureau of Plant Industry, Soils, and Agricultural Engineering
    Division of Forest Pathology
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Canadian Department of Agriculture
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POLE BLIGHT--WHAT IS KNOWN ABOUT IT

By

The Pole Blight Investigations Steering Committee[1]

INTRODUCTION

The Story of Pole Blight

About 25 years ago, a forester on the Kootenai National Forest saw what probably was the disease of western white pine that we now call pole blight. At the time the disorder was tentatively diagnosed as root rot. But 15 years ago, a handful of extra observant individuals were beginning to suspect that something harmful was affecting young western white pine in an unexplained way. Ten years ago, a relatively few foresters, pathologists, and entomologists knew that young western white pine trees in Idaho were dying in appreciable numbers from an unclassified, unidentified disorder. However, until about five years ago, pole blight did not even have a generally accepted name. Today, pole blight and its alarming potentialities for harm are widely known. It has been mentioned in Congress, in at least one Nation-wide radio broadcast, newspapers, and industrial and scientific journals.

Today, we know that pole blight exists in many young white pine stands in widely scattered localities. The chief symptoms have been well established and pole blight now can be recognized with a fair degree of certainty by many people. But we do not know the cause of the disorder, if it is infectious, and how it is transmitted.

1/ This report was drafted jointly by representatives of the agencies listed inside the front cover. It was published by the Northern Rocky Mountain Forest and Range Experiment Station, U. S. Forest Service, Department of Agriculture, Federal Building, Missoula, Montana.

The Pole Blight Investigations Steering Committee.

Much research effort has been put into the search for the cause of pole blight. As early as 1937, the School of Forestry at the University of Idaho and the U. S. Forest Service began to study cooperatively the disorder which is now called pole blight. Over a period of years, the interests and help of other organizations were enlisted and a systematic and coordinated program of research has been conducted. The research program is still continuing. The participating agencies have adopted the practice of meeting once each year for a program conference and they also exchange information four times per year through a mimeographed report which is compiled at the University of Idaho.

The informal and wholly voluntary task force of agencies which is seeking to learn the cause and means of prevention or control of pole blight calls itself the Pole Blight Investigations Steering Committee. The names of the principal participants are listed inside the front cover of this pamphlet. In addition to the names listed, several other public and private organizations have taken part in various ways at different times. All organizations or individuals that can assist in any constructive way are welcome to participate. The kind of studies conducted by the principal participating research agencies are listed below:

University of Idaho

Symptomology	-	Apparent and microscopic indications of disease.
Causal Agencies	-	Isolation, inoculation, and identification of fungi. Tests for viruses.
Occurrence and spread	-	Permanent observation plots.
Soils and Nutrition studies	-	Chemical and physical analyses of soil and tree tissues.
Radioisotope Studies	-	Translocation and absorption of minerals.
Experimental Control	-	Cutting out diseased trees.

Division of Forest Pathology

Symptomology	-	Root studies.
Occurrence and spread	-	Airplane and ground surveys.
Causal agencies	-	Isolation, inoculation and physiological studies of fungi.
Experimental Control	-	Topping, fertilizing. Search for resistant trees.

Division of Forest Insect Investigations

Causal Agencies	-	Diagnosis to determine if insects were instrumental.

Northern Rocky Mountain Forest and Range Experiment Station

Evaluation of Loss	-	Reduction in stand yield, salvage.
Experimental Control	-	Cutting, fertilizing, poisoning.

Dominion Laboratory of Forest Biology

Symptomology	-	Histological studies of white pine and lodgepole pine.
Occurrence and spread	-	Surveys.
Causal Agencies	-	Isolation, inoculation, and physiological studies of fungi.
Experimental Control	-	Thinning studies.

EXTENT OF POLE BLIGHT

Pole Blight in the United States.

The Inland Empire portion of eastern Washington, northern Idaho, and western Montana contains about 750,000 acres of pole-size white pine. Although recently a few instances of pole blight have been found in larger, older timber, practically all surveys for the disease have been confined to the 750,000 acres of pole-size trees. Between mid-summer of 1949 when systematic survey began, and the end of the field season in 1951 when the initial survey was completed, over 60,000 acres or about eight percent of the area in pole timber was found to be affected (Figure 1). The rating, "affected", means moderate to severe incidence of blight as evidenced by the presence of considerable numbers of fading or discolored tree crowns. It does not include stands with only an occasional diseased tree, or those trees which do not yet show crown symptoms.

Although some affected stands are in advanced stages of deterioration with a majority of the trees dead or dying, many contain a relatively small percentage of blighted trees. Consequently, on the basis of the present inadequate knowledge of spread and intensification, wholesale, rapid dying of the majority of trees in affected stands is not an immediate prospect. Rather, the prospects are for a comparatively gradual process of attrition. In some instances, marked intensification of the disease was observed between 1949 and 1951, and in others it was present in 1951 where little or none had been found in 1949.

The southernmost known extension of pole blight is on Disalto Creek about eight miles east of Harvard, Idaho. It is not known to exist in the Clearwater area, although the outbreak in Disalto Creek is only 35 miles to the north.

The systematic survey that was started in 1949 has been conducted by observation from low-flying airplanes, with follow-up checks on suspected areas by ground crews. A preliminary test in a low-flying airplane revealed that western white pine could be distinguished readily from its associated tree species from an airplane 200 to 500 feet above the tree tops, and that stands with moderate to severe pole blight could be distinguished from those with only an occasional pole-blighted tree or from entirely healthy stands. Survey crews have flown approximately 25,000 miles in the searches.

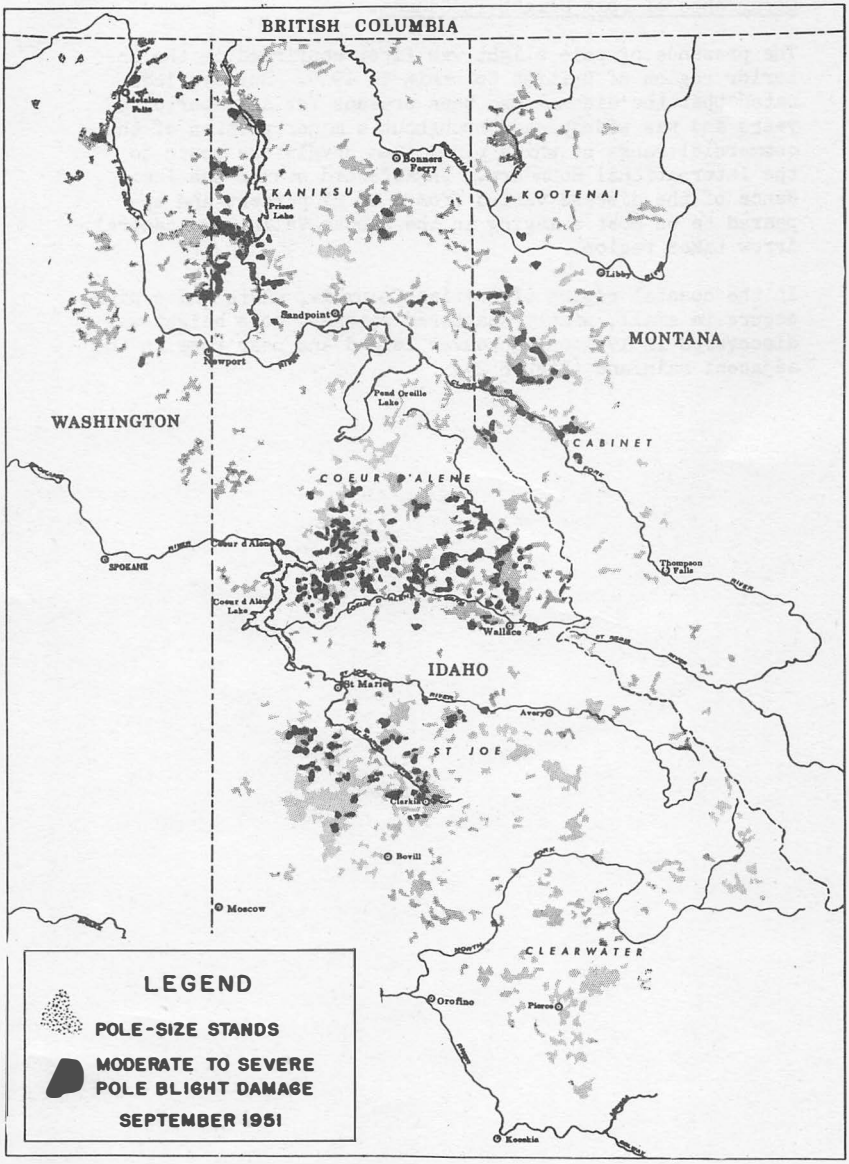

Figure 1. Known distribution of white pine pole blight in the United States, September 1951.

Occurrence of Pole Blight in Canada.

The presence of pole blight was first confirmed in the interior region of British Columbia in 1949. Surveys indicated that the disease had been present for a number of years and was widespread throughout a major portion of the commercial range of white pine, from Revelstoke south to the International Boundary. In affected stands the incidence of the disease varied from 4 to 67 percent and appeared to be most damaging in the Slocan Valley and central Arrow Lakes region.

In the coastal region of British Columbia, where white pine occurs in small, widely scattered patches, pole blight was discovered in 1951 on Vancouver Island and near Hope on the adjacent mainland (Figure 2).

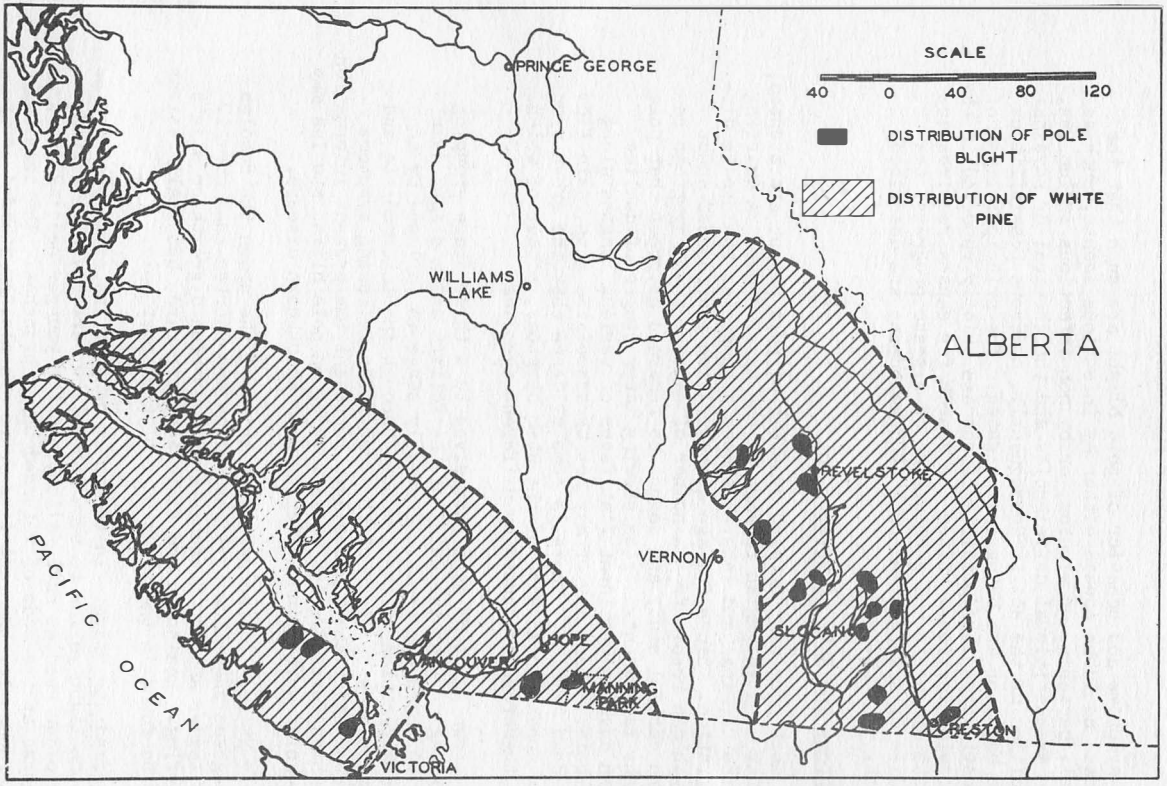

Figure 2. Botanical range of western white pine and known occurrence of pole blight in British Columbia

THE SEARCH FOR CAUSES

The symptoms and behavior of pole blight are such that the disease could be caused either by infectious agents, such as fungi, bacteria, or viruses, or by non-infectious influences, such as nutritional deficiencies and the chemical or physical condition of the soil. Consequently, numerous possibilities have been, or are being investigated. The principal lines of investigation into possible causes are briefly reported in the following sections. Since the search for causes requires accurate diagnosis and a knowledge of disease progress, the studies of symptoms and rate of development are described first.

Symptoms and Rate of Development

The most prominent outward symptoms of pole blight are stunted, scanty, and yellowish foliage in the upper crown. A dwarfing of the terminal and lateral shoots accompanies the needle discoloration. Since foliage discoloration and reduced shoot growth can result from a number of causes, these symptoms require careful study and cannot be regarded as proof that pole blight is present. Trees showing later stages of decline often develop prominent flat faces of various lengths along the bole. These may or may not be associated with resin flow and dead cambium. There is some evidence that the crown symptoms appear in advance of the stem symptoms, either of which may therefore be caused by different agencies.

The crown symptoms lend themselves to a three-stage grouping that begins with yellowing of the foliage and a slight dwarfing in the upper crown. The early stage is followed by an intensification of the symptoms through the intermediate and final stages to death of the tree. The following symptoms grouped under the three stages represent the present information by which foresters and those working on pole blight studies may recognize white pine suffering from an unknown disease.

Early Stage. In the upper one-third of the crown the needles are greenish-yellow to light yellow and shorter than normal. The leader and top branches show a shortened growth or slight dwarfing. Resinosis and flat faces are rare, but small lesions may be found in the young bark of the upper bole.

Intermediate Stage. In the upper half of the crown the needles become light yellow to brownish-yellow, are plainly dwarfed, the older needles have fallen, and the younger needles appear bunched at the ends of upturned upper branches. The terminal internodes for the last five years are plainly dwarfed as are those of the branches. If present, resinosis may be light to

heavy and in some trees narrow, long, dead areas may appear in the bark. Cones are often discolored and dwarfed. However, cone weevils sometimes cause similar discoloration and dwarfing of cones.

Final Stage. In the entire crown, or at least two-thirds of it, the needles appear yellow to yellowish-brown and dying. The foliage is scanty and bunched at the ends of the branches. There is a decided dwarfing of terminal and lateral shoots. If present, the resinosis is usually heavy; the flat faces larger and more numerous. The tree is dying. Dead trees, of course, represent the ultimate stage. However, in order to assign the unknown pole blight agency as the cause of death of a tree, the tree must bear the proper supporting evidence such as crown discolorations, flat faces with dead cambium underneath, and reduced stem and shoot growth.

The above symptoms point to pole blight when a careful examination of crown, bole, and root spurs has eliminated all known causal agencies. Furthermore, the dead tree must not bear evidence of having been killed by some other agency.

Results of studies made on disease progress plots indicate that pole blight is steadily increasing in severity with a continuing mortality. A study of mortality in all of the tree species in the plots has separated trees which died with only pole blight symptoms from those which died of other known causes. The plot data also indicate that pole blight is a relatively slow killer. The time from appearance of first symptoms until death of a tree probably is roughly 8 or 10 years on the average.

Pole blight generally is found in trees between 40 and 100 years in age. The youngest age at which it has been identified is 35 years and the oldest, 175 years. Observations of occurrence among trees more than 100 years old have been infrequent. However, since diagnosis is rather difficult, and most search has been concentrated in the younger stands, a possibility exists that many more older trees are subject to the disease than has been suspected.

Disease Organisms.

Investigations of several fungi associated with diseased trees have been started as have preliminary tests designed to show whether or not a virus is involved.

Fungi are generally tested as possible causal organisms by (1) isolating a suspected fungus from a diseased tree, (2) growing it in pure culture, and (3) inoculating healthy white pines with this isolate. If the inoculated trees develop symptoms of the disease and the fungus which was introduced is reisolated, proof of the cause is established, provided an adequate number of checks show that the inoculated individuals had not contracted the disease naturally.

More than a score of fungi have been isolated from blighted trees, the most consistently present ones being Leptographium sp. and Armillaria mellea. Since 1947, over 750 healthy trees have been inoculated with various fungi but thus far only one, Leptographium sp., has produced what are regarded as partly positive results. Lesions and resinosis similar to those found on naturally blighted trees have been produced by this fungus. However, no typical foliar or crown symptoms have been observed which can be attributed to the effect of this fungus. Before the remaining steps for proof can be completed, a period of observation awaiting more positive or negative results will be required. Limited numbers of seven associated tree species of western white pine have also been inoculated with Leptographium. To date, results on lodgepole pine and ponderosa pine are somewhat similar to those on western white pine. Those on Douglas-fir and grand fir have in some instances been considered negative at the end of one year, and in some instances the reactions have been similar to those on white pine but of lesser extent. The reactions on western larch, western hemlock, and western redcedar have been considered negative. Seedlings of western white pine directly inoculated with the same fungus in the laboratory have been killed in some cases, in others no direct effect has been noticed. Sterile extracts from Leptographium and A. mellea have been injected into potted white pine seedlings in the laboratory and have showed no toxic results.

The presence of a virus is generally demonstrated through various techniques by grafting portions of the diseased trees to similar areas on healthy stock or vice versa. No intensive work of this nature has yet been undertaken but plans have been formulated to step up the inquiry. Previous experiments have been concerned primarily with learning the techniques. Patch-grafting has been attempted but where the grafts have been successful no abnormal disturbances have resulted to date.

Soils

The general physical appearance of pole blighted trees reminds one of plants suffering from a nutrient deficiency and it was natural that people should ask if pole blight might be related in some way to soil conditions. To test this possibility, samples were taken from a number of soil plots in the western white pine area. Records were made of the parent material of the soil, the depths of the various soil horizons, the texture of the horizons, the depth and weight of organic matter, the site index of the area, the exposure of the plot, the percent slope, the elevation, and the topographic position. In addition, the soil samples were analyzed in the laboratory for carbon content (organic matter), nitrogen content, active acidity (pH), and internal drainage (moisture equivalent).

The soil studies indicate that pole blight occurs over a wide range of soil conditions. It may be found on all sorts of parent material from schists to argillites to alluvium, on all exposures, at all elevations in the western white pine region, on all degrees of slope, on all sorts of topographic positions, and on all sites from poor to excellent. An equally wide range is found upon analyzing the other soils data. Pole blighted trees may occur on soils either high or low in nitrogen and organic matter, either acid or nearly neutral, on soils deep or shallow, and on soils light or heavy in texture. On the average, pole blight infected stands occur on slightly poorer sites than do healthy stands in the same area, and the organic matter and nitrogen content of the soils on pole blighted sites is lower on the average than that where trees are healthy. In spite of these tendencies it is evident that soil conditions which have been studied are not limiting factors in pole blight distribution.

Nutrition.

Because of the stunted, yellow, and unhealthy appearances of the foliage of pole blighted trees, needles from blighted and from adjacent healthy trees were collected and taken to the laboratory for analysis and comparison. The analyses revealed that the foliage of pole blighted trees is deficient in nitrogen, calcium, magnesium, manganese, and boron, while they have greater than normal amounts of phosphorus and potassium. These deficiencies suggested field trials to determine whether addition of certain elements to the soil would enable blighted trees to recover or perhaps prevent the onset of the condition. Previous exploratory experiments indicated that fertilizers had no effect on recovery, so prevention by application of fertilizers was attempted. Apparently-healthy trees in pole blighted areas have been heavily fertilized with nitrogen, boron, and calcium and adjacent healthy trees have been left unfertilized to serve as checks. The experiments are too new to permit definite conclusions. However, the preliminary results indicate that fertilizers have little effect in prevention of pole blight.

As part of the program to learn more about the mineral nutrition of healthy and pole blighted western white pines, the University of Idaho has obtained a contract with the Atomic Energy Commission to carry on experiments with the absorption and translocation of radioactive phosphorus and calcium in pole-sized trees under field conditions, and seedlings in the greenhouse. Analysis of the data obtained during 1951 reveals some striking differences between the matabolism of healthy and that of pole blighted trees. It is hoped to correlate these differences with those brought about by known fungus organisms to give a clue as to the nature of the cause of the disease.

EXPERIMENTAL CONTROL

Until the cause of pole blight has been determined, attempts to control it are something like hitting in the dark. Nevertheless the committee agreed that the most obvious possibility for control - removal of visibly affected trees from experimental plots - should be tried. However, experimental control ideally requires a rather large area (possibly 1,000 acres) of thrifty pole-sized timber in which pole blight is just beginning to appear. The trees on this tract would be examined yearly and all pole blight affected stems removed. A tract of timber with the proper conditions for such a test has not yet been found, and in addition the great amount of effort to examine and eliminate infected trees on such a large tract annually has not been possible. As a substitute, we have been content with establishing plots of smaller size more with the intention of obtaining information on the effect of various cuttings on pole blight rather than as real attempts of experimental control through cutting.

A number of small cutting plots have been established. In 1949 all pole blighted trees were removed on a five-acre plot on the Coeur d'Alene Forest. A similar five-acre plot was left uncut as a control. Preliminary observations indicate that pole blight has continued to spread. A similar but more comprehensive experiment was undertaken on the Kaniksu National Forest in 1951. The study includes nine plots, each about nine acres in size. Three of these plots are untreated check plots. On the other six plots, all merchantable pole blighted trees have been logged. In addition, all non-merchantable pole blighted trees have been poisoned on three of these six plots. Because all tree species present on the area will be measured and studied, these plots will supply important information on both the nature of pole blight and growth and succession in pole blighted stands. Canadian agencies installed a total of 54 plots, 0.2 acre in size, at Silverton, British Columbia, in 1950, and at Makison Flats, British Columbia, in 1951. All blighted pine on 34 or the plots and on 9.1 acres of isolation strip have been felled and removed. The remaining 20 plots serve as check plots for the cut plots and as disease progress plots.

SUMMARY

Investigations by a group of forestry agencies which is known collectively as the Pole Blight Investigations Steering Committee have resulted in showing that pole blight is far more extensively distributed and is even more of a threat to the future of the white pine lumber industry than was suspected earlier. Today it is known to be present in most pole-size stands of western white pine north of the Clearwater district in Idaho, in adjacent portions of Washington and Montana, and the interior and coastal regions of British Columbia, and on Vancouver Island. It has definitely increased in intensity of infection since the time of first systematic observations about 15 years ago.

Pole blight has been found occurring in trees from about 35 to 175 years in age--a much greater spread in age of susceptibility than was recognized at first. The recognition of pole blight in a stand depends upon the care used in recognizing symptoms which are not traceable to known agencies. This is not easy, but a careful diagnosis of each tree will aid in eliminating known causes of decline.

The cause of pole blight has not been determined although a wide variety of studies has been started. Whether pole blight will eventually kill all of the white pine trees in affected stands cannot be determined until it has run its course. Experimental control is being conducted on a limited scale, but such tests have only poor possibilities for success in the absence of an understanding of the cause.

No assurance can be given that the present investigation program will lead ultimately to the answers that are desired--the cause of pole blight and how it can be prevented or controlled. However, a sustained and strengthened research program offers the best promise for getting the answers as quickly as possible.

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